



Statewide Investigation of Medically Attended Adverse Health Conditions of Persons With Spinal Cord Injury

Elisabeth Pickelsimer, DA¹; Eric J. Shiroma, MS²; Dulaney A. Wilson, PhD³

¹Medical University of South Carolina, Charleston, South Carolina; ²Harvard University, Cambridge, Massachusetts;

³Pacific Northwest National Laboratory, Richland, Washington

Received August 12, 2009; accepted February 20, 2010

Abstract

Background/Objective: To report over a 10-year period the statewide prevalence and incidence of medically attended adverse health conditions in people with new traumatic spinal cord injury (TSCI).

Design: Retrospective cohort study.

Methods: (a) Identified all new TSCI cases discharged alive from statewide acute care hospitals, 1996 to 2000, using ICD-9-CM methodology. (b) Followed cases from 1996 to 2005 to quantify medically attended health conditions documented during emergency department visits, acute care hospitalizations, and outpatient hospital visits. (c) Used the life table method to calculate the prevalence and incidence of health conditions. (d) Examined Cox proportional hazard ratio of mortality by gender controlling for age and TSCI severity.

Results: Nine hundred eighty-eight residents (257 women, 731 men) with TSCI were alive 90 days after discharge from acute care hospitalization from 1996 to 2000. Nine hundred twenty-three (251 female, 672 male) (93.4%) residents had an observed medically attended adverse health condition in the 10-year follow-up period. The most prevalent classes of diseases and disorders were (a) muscle and connective tissue, (b) renal and urinary, (c) digestive, (d) circulatory, (e) respiratory, (f) endocrine/nutritional/metabolic, and (g) infectious. Incidence of new injury was 29.0% for males and 26.9% for females. During the follow-up period, 49 women (19%) and 104 men (14%) died.

Conclusions: People with TSCI experience diverse adverse health conditions in the 10 years after initial injury. An interdisciplinary health care provider team approach to allocating resources and implementing countermeasures to prevent or limit occurrence of these conditions is vital to these patients' continuum of care.

J Spinal Cord Med. June 2010;33(3):221–231

Key Words: Spinal cord injuries, traumatic; Demographics; Secondary complications, age, gender; Prevalence; Incidence

Please address correspondence to Elisabeth Pickelsimer, DA, Medical University of South Carolina, 135 Cannon Street, MSC 835, Charleston, SC 29425; p: 843 876 1594; f: 843 876 1126 (e-mail: pickelse@muscc.edu).

The South Carolina Spinal Cord Injury Research Fund (award #0705) sponsored this study [PI: E. Elisabeth Pickelsimer].

Affiliations at the time of manuscript preparation: master's student (E. J. S.), doctoral student (D. A. W.), Department of Biostatistics & Epidemiology, Medical University of South Carolina, Charleston, SC 29425.

© 2010 by the American Paraplegia Society

INTRODUCTION

People with traumatic spinal cord injury (TSCI) are at increased risk of developing on-going adverse health conditions that require hospital care (1–3) and physician office and emergency department (ED) visits (4). During the first year after injury, hospitalizations are commonly related to the original injury (1,5,6). Primary reasons for hospitalizations after year 1 include cardiopulmonary complications; urinary complications; dermatologic conditions (7); digestive, musculoskeletal, and nervous system complications; and secondary fractures of the lower limbs (8,9). Conditions considered secondary to SCI can lead to death (10,11). Although higher-level and

neurologic completeness of spinal cord lesion (1,12,13) significantly increases the likelihood of hospitalization and further disability, (14) many TSCI-related secondary conditions are modifiable or preventable (6,7).

Gender differences in terms of adverse health conditions have been reported among people with TSCI (15–17). However, age comparisons between genders are potentially confounded by age at onset, duration of disability, and neurologic level of injury (2).

Morbidity and survival of people with TSCI have mainly been reported for cross-sectional samples (9,18–22) or for limited ages or degrees of injury severity (1,5,23). Thus, the ability to generalize findings to all people with TSCI is limited. To fill this void, this study reports the prevalence and incidence of medically attended health conditions across all ages and TSCI severity over a 10-year follow-up period in a statewide population. To our knowledge, this is the first article to report these findings.

METHODS

Data Sources

The Institutional Review Board of the Medical University of South Carolina approved the study. This study examined 2 statewide datasets, the State of South Carolina Acute Care and Outpatient Hospital Discharge Data Set and the South Carolina Emergency Department Visit Data Set. State law mandates that all 62 EDs and 62 nonfederal hospitals in the state report data abstracted from the discharge uniform billing system to the Office of Research and Statistics of the State Budget and Control Board. The data set contains demographics, dates of admission and discharge, up to 10 diagnosis codes documented according to the International Classification of Diseases, 9th Revision, Clinical Modifications (ICD-9-CM) (24), primary and secondary external causes of injury codes, total charges, discharge dispositions, source of admission, principal payers, types of care, and patient identifiers. Inclusion of personal identifiers prevented duplication of repeat visits for the same event. The reliability and utility of administrative health care data have been established (18,25–28). The advantages of using health care billing data are that they provide documentation of individual encounters and allow assessment of adverse health conditions in a large and complete population (25). In addition, the use of ICD-9-CM methodology to identify morbidities has been determined to be a reliable alternative to chart review (29).

Study Population

ICD-9-CM methodology identified 1,008 state residents who sustained a TSCI that resulted in an ED visit or an acute care hospital discharge in the state from January 1, 1996, through December 31, 2000. Patients ($n = 20$) who died within 89 days of initial ED visit or hospital discharge were considered to have trauma-related deaths

and were excluded. A case of TSCI was defined as any hospital discharge or ED visit with a primary or secondary diagnosis of TSCI in accordance with the Centers for Disease Control and Prevention case definition of incident TSCI (30). The nature of injury codes (N-codes) used were 806.0–806.9 (fracture of vertebral column with spinal cord lesion) or 952.0–952.9 (spinal cord lesion without evidence of spinal bone injury). The fourth and fifth digits of the 806 and 952 N-codes were further used to identify level and completeness of injury. Spinal cord injury type was defined as “unclassified” when these digits were missing. Other researchers have used ICD-9-CM-based methodology to identify TSCI cases (31–34) and to identify secondary conditions in people with disabilities (18). State legislative authority (§44-38-60) helped the study obtain mortality status through linkage of a unique combination of name, social security number, gender, date of birth, and last known address with the state vital records dataset.

Follow Up

For follow up, ICD-9-CM methodology, as identified in Table 1, was further used to identify morbidities recorded in the medical record during visits in 1996 to 2005 to an ED, an acute care hospital, or an outpatient hospital clinic in the state. Diagnosis codes for late effects of TSCI, aftercare, plegias, phantom limb, and complications or conditions secondary to a procedure, surgery, graft, or prevalent disease were excluded. We further excluded diagnosis codes for conditions related to pregnancy, childbirth, and puerperi/perinatal, and dental status; congenital anomalies, hereditary disorders, genetic disorders and conditions, mental retardation, vision and auditory conditions, screening visits, and status codes. Remaining health classes and conditions were classified according to ICD-9-CM methodology. Each condition was counted at each occurrence.

For each case, TSCI severity was determined by translating the ICD-9-CM diagnosis codes into an ASIA impairment scale score for the spine region using ICDMAP-90 software (35). If the fifth digit of the diagnosis code was missing, the least severe rating was assigned. Traumatic SCI severity was then categorized based on the ASIA impairment scale score as “critical” (5–6), “severe” (4), or “moderate” (2–3).

Gender differences in demographics and injury characteristics were examined using chi-square, Fisher exact, or Wilcoxon rank sum tests, where appropriate. Prevalence and incidence of disease classes and major health conditions were calculated by the time-to-event life table method and are reported separately by gender. Date of first observed diagnosis code for a specific condition was used as the time of first event. Conditions treated within 89 days of initial hospitalization were considered baseline conditions. The at-risk population at time of subsequent medically attended events was

Table 1. Classification of Diseases and Disorders

Groupings	ICD-9-CM Codes
Infectious and parasitic diseases	001–136.9
Septicemia, bacteremia ^a	038–038.9; 790.7
Neoplasms	140–239.9
Malignant	140–209.9; 229–239.9
Nonmalignant	210–228.9
Endocrine, nutritional, metabolic diseases, immunity disorders	240–279.9
Diabetes	250–250.9
Nutritional deficiencies	260–269.9
Fluid, electrolyte, acid/base	276–276.9
Blood and blood-forming organ disease	280–281.9; 283–289.9
Mental disorders	
Alcohol and drug	291–292.9; 303–305.9
Stress, depression, adjustment	296.2–296.3; 296.8; 308–309.9; 311–311.9
Other mental health	290–290.9; 293–296.1; 296.4–296.7; 296.9–302.9; 306–307.9; 310–310.9
Nervous system and sense organ disease	320–325.9; 327–334; 334.2–341.9; 345–348.9; 349.2–353.5; 353.7–355.9, 780.30, 780.39
Convulsions, seizures ^a	345–345.9, 780.30, 780.39
Circulatory system disease	390–404.9; 406–437.9; 439–459.9
Hypertension	401
Ischemic heart, chest pain	410–414.9; 786.5
Cerebrovascular	430–437.9
Respiratory system disease	460–518.4; 518.6–519.9
Pneumonia	480–486.9
Chronic obstructive pulmonary disease and allied conditions	490–496.9
Pulmonary effusion, pneumothorax, pulmonary collapse, acute respiratory failure	511–512; 518.0; 518.8
Digestive system disease	526–535.2; 535.4–570.9; 572–579.9
Gastrointestinal ulcers	530.0–534.9
Gastritis and duodenitis	535
Intestinal obstruction and constipation	560.0–560.99; 564.0
Neurogenic bowel	564.8–564.89

Table 1. Continued

Groupings	ICD-9-CM Codes
Genitourinary system disease	580–629.9
Kidney infection	590–590.9
Neurogenic bladder	596.5
Urinary tract infection	599.0
Skin and subcutaneous tissue disease	680–709.9
Chronic skin ulcer	707–707.9
Musculoskeletal and connective tissue disease	710–739.9
Rheumatoid arthritis, osteoarthritis	714–715.9
Joint or back pain	719.4; 724.1–724.2; 729.5
Disk disorder	721–724.0; 724.3–724.9
Osteomyelitis	730–730.9
Other conditions	
Abnormal involuntary movement	781.0
Malaise, fatigue, sleep disorder	780.5; 780.7
Injury and poisoning	
Extremity fracture, dislocation, sprain, traumatic amputation	807–829.9; 831–838.9; 840–848.9; 885–887.9; 895–897.9
Traumatic brain injury, spinal cord injury, fracture of head, neck, face, spine	800–806.9; 830–830.9; 839–839.9; 850–854.9; 925–925.9; 950–953.9
Poisoning	960–989.9
Other injury	860–884.9; 890–894.9; 900–904.9; 910–924.9; 927–949.9; 954–959.9; 990–994.4

^a Reclassified from other conditions.

calculated as people alive at the beginning of the interval minus half of the censored observations during the observation period. Total or prevalent health conditions include baseline conditions. New or incident conditions refer to those observed 90 or more days after date of first hospital admission.

Detailed prevalence and incidence analyses of specific ICD-9-CM classes were conducted if the umbrella category had a large proportion of cases with at least 1 medically attended condition after TSCI and if the specific medical condition was potentially TSCI related. In addition, a descriptive analysis was conducted of the frequency of injuries and acute conditions per person of those who had a repeat occurrence after baseline. Injuries or acute conditions were considered new if dates of service appeared at intervals greater than 7 days. Baseline injuries are not discussed, because they are implicit in the

Table 2. Patient Characteristics by Gender

		Women	Men	P Value
Age at TSCI	N	257	731	0.001
	Mean	44.8	39	
	Median	42	37	
	SD	23.11	17.02	
	Age range	1–93	<1–89	
Race	White	186 (72.4%)	431 (59%)	<0.001
	Nonwhite	71 (27.6%)	300 (41%)	
SCI type	Cervical complete	15 (5.8%)	58 (7.9%)	0.001
	Thoracic complete	11 (4.3%)	28 (3.8%)	
	C/T incomplete	27 (10.5%)	110 (15%)	
	Cervical unspecified	76 (29.6%)	282 (38.6%)	
	Thoracic unspecified	54 (21%)	90 (12.3%)	
	Lumbar	43 (16.7%)	81 (11.1%)	
	Unclassified	31 (12.1%)	82 (11.2%)	
TSCI severity by ASIA impairment scale grouping	Critical (5–6)	26 (10.1%)	96 (13.1%)	0.084
	Severe (4)	56 (21.8%)	209 (28.6%)	
	Moderate (2–3)	152 (59.1%)	368 (50.3%)	
	Minor (1)	1 (0.4%)	1 (0.1%)	
	Unclassified	22 (8.6%)	57 (7.8%)	
Concurrent TBI	Yes	30 (11.7%)	118 (16.1%)	0.084
	No	227 (88.3%)	613 (83.9%)	

TBI, traumatic brain injury, TSCI, traumatic spinal cord injury.

inclusion criteria. A Cox regression survival analysis, using the Efron method (36) for ties, examined the hazard rates in men and women controlling for age and TSCI severity. Collinearity, concordance statistics, and the proportional hazard assumption were examined during model building. SAS 9.1 (37) and STATA9 (38) software were used to conduct the statistical analyses.

RESULTS

Table 2 shows the characteristics of the 731 men and 257 women who met the inclusion criteria. Overall, they differed significantly in age at TSCI, race, and type of SCI. No significant difference in the proportion of concurrent traumatic brain injury by gender was observed.

In total, 923 patients (93.4%) had 1 or more postinjury ED visits, hospitalizations, or hospital-associated outpatient visits in South Carolina during the 10-year follow-up period. More specifically, 56.6% were treated and released from an ED, 62.5% were admitted to an acute care hospital, and 26.7% received care in a hospital-associated outpatient clinic. Table 3 shows frequencies of medically attended adverse disease classes and injuries classified using ICD-9-CM methodology that were observed within the first 89 days after injury, 90 days to 1 year, 1 to 5 years, and 5 to 10 years. Overall, the 7 most prevalent disease classes were muscle/connective tissue, genitourinary, renal and urinary,

digestive, circulatory, respiratory, endocrine/nutritional/metabolic, and infectious.

For men, the 5 most prevalent disease or disorder classes were muscle/connective tissue, genitourinary, digestive, circulatory, and respiratory. All classes had prevalence greater than 63%. For women, the 5 most prevalent classes respectively were genitourinary, muscle/connective tissue, endocrine/nutritional/metabolic, circulatory, and digestive. All classes had a prevalence rate greater than 70%. New or incident cases were observed at least 90 days after initial injury. For men, the 5 classes of diseases and disorders with highest incidence were muscle/connective tissue, digestive, genitourinary, endocrine/nutritional/metabolic, and respiratory. All classes had an incidence rate greater than 46%. For women, the 5 classes for new cases were the same as the prevalent classes, with an observed incidence of 50% or greater.

Incidence of each injury class observed 90 days to 10 years from the incident TSCI is listed by gender on Table 3. The at-risk population for incidence calculations is based on time after TSCI to first event. The occurrence of extremity fracture, dislocation, sprain, and amputation was 29% for men and 26.9% for women. Also, 13.8% of women and 11.1% of men had an observed case of traumatic brain injury; TSCI; or fracture of the head, neck, face, or spine after initial injury. The other

Table 3. Prevalence and Incidence of Health Classes and Selected Conditions in Women (W) and Men (M)

	Baseline		90 days–1 year		1–5 years		5–10 years		Total Conditions		New Conditions ^a	
	W	M	W	M	W	M	W	M	W	M	W	M
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Infectious and parasitic disease	48 (18.7)	119 (16.3)	19 (9.2)	59 (9.7)	36 (20.2)	83 (15.5)	11 (14.9)	28 (12)	114 (61.5)	289 (56.7)	66 (48)	170 (43.5)
Neoplasm												
Malignant	5 (1.9)	3 (0.4)	2 (0.8)	7 (1)	7 (3.1)	14 (2.1)	5 (4.7)	18 (5.5)	19 (13.8)	42 (10.9)	14 (10.5)	39 (10.2)
Nonmalignant	1 (0.4)	2 (0.3)	4 (1.6)	4 (0.6)	8 (3.6)	32 (4.7)	10 (9.4)	15 (4.8)	23 (16.4)	53 (13.5)	22 (15.8)	51 (13.1)
Endocrine, nutritional, metabolic, immunity	67 (26.1)	126 (17.2)	21 (11.1)	42 (7)	43 (26.1)	102 (18.7)	12 (18.2)	46 (19)	143 (71.5)	316 (60.4)	76 (57.1)	190 (47.8)
Blood disease	40 (15.6)	106 (14.5)	15 (7)	36 (5.8)	25 (13.2)	70 (12.3)	9 (10.8)	23 (9)	89 (51.4)	235 (48.7)	49 (36.8)	129 (34.2)
Mental disorder												
Alcohol or drug	19 (7.4)	127 (17.4)	8 (3.5)	26 (4.4)	19 (9.4)	71 (13.1)	5 (5.7)	47 (18.8)	51 (33.1)	271 (54.1)	32 (23.7)	144 (38.5)
Stress, adjustment, depression	27 (10.5)	40 (5.5)	4 (1.8)	20 (2.9)	22 (10.9)	44 (7)	11 (12.1)	15 (5.2)	64 (39.9)	119 (28)	37 (27.7)	79 (20.5)
Other	23 (8.9)	28 (3.8)	15 (6.6)	19 (2.7)	23 (11.4)	40 (6.2)	12 (13)	14 (4.7)	73 (44.2)	101 (24.3)	50 (35.2)	73 (18.8)
Nervous system disease	24 (9.3)	32 (4.4)	10 (4.4)	14 (2)	28 (13.7)	54 (8.4)	9 (10.1)	19 (6.5)	71 (43.3)	119 (28)	47 (33.6)	87 (22.1)
Convulsion/seizure ^b	9 (3.5)	16 (2.2)	2 (0.8)	10 (1.4)	9 (4.1)	25 (3.8)	3 (3)	16 (5.1)	23 (16.4)	67 (16.8)	14 (10.7)	51 (13.3)
Circulatory system disease	81 (31.5)	182 (24.9)	13 (7.4)	36 (6.6)	32 (20)	96 (19.3)	15 (21)	34 (15.9)	141 (70.9)	348 (64.5)	60 (50.8)	166 (46.4)
Respiratory system disease	73 (28.4)	172 (23.5)	18 (10)	41 (7.4)	27 (17.4)	95 (19)	11 (16.3)	34 (15.9)	129 (66.8)	342 (63.7)	56 (46.7)	170 (46.6)
Digestive system disease	55 (21.4)	151 (20.7)	24 (12.2)	56 (9.7)	49 (29.9)	124 (24.5)	11 (18)	34 (16.6)	139 (70.2)	365 (66.6)	84 (58.7)	214 (53.9)
Genitourinary system disease	95 (37)	205 (28)	33 (20.6)	68 (13)	35 (28.6)	82 (18.5)	9 (19.4)	23 (12.2)	172 (80.2)	378 (68.2)	77 (64.4)	173 (49.5)
Skin and subcutaneous tissue disease	13 (5.1)	70 (9.6)	18 (7.5)	63 (9.6)	29 (13.8)	89 (15.6)	14 (15)	32 (12.8)	74 (44.7)	254 (51.6)	61 (40)	184 (43.6)
Chronic skin ulcer	9 (3.5)	55 (7.5)	12 (4.9)	51 (7.6)	16 (7.4)	54 (9.1)	6 (6.1)	17 (6.3)	43 (28.7)	177 (39.0)	34 (24.1)	122 (30.6)
Musculoskeletal and connect tissue disease	100 (38.9)	204 (27.9)	19 (12.3)	63 (12.1)	39 (29.3)	117 (26.7)	13 (24.5)	33 (19.2)	171 (79.9)	417 (72.6)	71 (62.3)	213 (57.6)
Other conditions												
Abnormal/involuntary movement	4 (1.6)	17 (2.3)	6 (2.4)	9 (1.3)	5 (2.3)	25 (3.8)	4 (3.9)	6 (2.0)	19 (13.8)	57 (14.5)	15 (11.2)	40 (10.6)
Malaise, fatigue, sleep disorder	6 (2.3)	10 (1.4)	5 (2.1)	6 (0.8)	13 (5.9)	29 (4.4)	6 (5.9)	17 (5.4)	30 (20.9)	62 (15.6)	24 (17.5)	52 (13.5)

Table 3. Continued

	Baseline		90 days–1 year		1–5 years		5–10 years		Total Conditions		New Conditions ^a	
	W	M	W	M	W	M	W	M	W	M	W	M
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Injury, poisoning												
Extremity fracture, dislocation, sprain, amputation	7 (2.7)	24 (3.3)	6 (2.5)	23 (3.3)	22 (10.2)	61 (9.6)	10 (10.5)	37 (12.7)	45 (29.8)	145 (33.1)	38 (26.4)	121 (29.2)
TBI, SCI, fracture of head, neck, face, spine	NA	NA	0 (0)	8 (1.1)	13 (5.7)	21 (3.1)	6 (5.7)	14 (4.4)	NA	NA	19 (13.8)	43 (11.1)
Poisoning	0 (0)	2 (0.3)	1 (0.4)	4 (0.6)	8 (3.5)	28 (4.2)	5 (4.7)	10 (3.2)	14 (10.3)	44 (11.4)	14 (10.3)	42 (10.9)
Other injury	NA	NA	13 (5.2)	39 (5.4)	41 (18.7)	112 (17.3)	18 (19.5)	70 (24.1)	NA	NA	72 (43.8)	221 (46.4)

TBI, traumatic brain injury.

^a Subsequent to traumatic SCI.^b Reclassified from other conditions.

subclassification includes a high prevalence of injury caused by complications from surgery.

Specific conditions within each class that have been reported to have a high incidence rate among people with TSCI (5,18). Table 4 reflects a breakdown of the most prevalent conditions within classes requiring medical intervention during the follow-up period at an ED, hospital, or outpatient hospital-affiliated physician office. Approximately 20% of men and women received medical attention for septicemia or bacteremia at least once. Nearly 50% of women and 41% of men had a new urinary tract infection. In addition, 24% of women and almost 31% of men were treated for chronic skin ulcers. Other new medical conditions observed in more than 20% of the population were fluid, electrolyte, or acid/base disorders; hypertension; ischemic heart disorder or chest pain; pneumonia; chronic obstructive pulmonary disease or allied condition; gastrointestinal ulcer; intestinal obstruction or constipation; pain; and disk disorders.

Table 5 reflects descriptive statistics on repeat injuries or acute medical conditions. Of those cases with at least 1 medical condition or injury, 33.71% of women and 48.33% of men had 3 or more episodes of urinary tract infection at least 7 days apart. Nearly 50% of women and 60% of men had 3 or more episodes of skin ulcers during the follow-up period. Additionally, 28% of women and 29% of men had 3 or more episodes of dehydration and/or potassium or sodium deficiency.

Mortality

During the 10-year follow-up period, 49 women (19.1%) and 104 men (14.2%) died. Using a Cox survival regression model, we found no difference between genders for mortality after controlling for age and TSCI severity (HR = 1.19; 95% CI: 0.82, 1.74). The type 3 χ^2 *P* value for gender was 0.36. The Supremum test for proportional hazards assumption held that the 2 curves based on gender did not differ (*P* = 0.61).

DISCUSSION

This study used administrative billing data and ICD-9-CM methodology to identify incident TSCI cases over a 5-year period. Overall, 988 patients met the inclusion criteria. Gender differences were noted for age, race, and type of TSCI. ICD-9-CM methodology was further used to identify medically attended adverse health conditions documented during patient admissions to acute care hospitals, outpatient hospital clinics, and EDs statewide over a subsequent 10-year follow-up period. It is of interest that, based on the life table method, the highest incidences of conditions considered secondary to TSCI were recorded in the first 5 years after injury, a finding also reported elsewhere (1,12,23,39).

Of the 988 patients, 153 (15.5%) had died over the follow-up period. Three studies reporting mortality over a 10-year period after TSCI found occurrences of 7% and

Table 4. Most Prevalent Health Conditions Within Each Disease Class in Women (W) and Men (M)

	Baseline		90 days–1 year		1–5 years		5–10 years		Total Conditions		New Conditions	
	W	M	W	M	W	M	W	M	W	M	W	M
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Septicemia and bacteremia	8 (3.1)	24 (3.3)	6 (2.5)	17 (2.4)	13 (5.8)	45 (6.9)	7 (6.8)	28 (9.1)	34 (23.4)	114 (27.0)	26 (18.9)	90 (22.6)
Diabetes	21 (8.2)	36 (4.9)	3 (1.3)	8 (1.2)	13 (6.2)	23 (3.6)	5 (5.2)	16 (5.2)	42 (28.1)	83 (20.4)	21 (16.3)	47 (12.7)
Nutritional deficiencies	9 (3.5)	8 (1.1)	6 (2.5)	8 (1.1)	7 (3.1)	27 (4)	6 (5.6)	19 (5.9)	12 (8.9)	42 (10.9)	19 (14.2)	54 (13.9)
Fluid, electrolyte, acid/base disorder	32 (12.5)	74 (10.1)	20 (9)	31 (4.8)	43 (22)	93 (15.4)	13 (16.1)	37 (13.7)	108 (59.2)	235 (48.7)	76 (50.5)	161 (39.4)
Hypertension	47 (18.3)	93 (12.7)	9 (4.4)	21 (3.3)	20 (10.6)	75 (12.9)	16 (17.8)	28 (10.9)	92 (52.7)	217 (45.8)	45 (35.3)	124 (32.5)
Ischemic heart and chest pain	13 (5.1)	40 (5.5)	12 (5.0)	16 (2.3)	32 (15.0)	67 (10.6)	12 (12.8)	36 (12.5)	69 (42.3)	159 (35.7)	56 (37.3)	119 (29.4)
Cerebrovascular	8 (3.1)	11 (1.5)	1 (0.4)	3 (0.4)	10 (4.5)	14 (2.1)	5 (4.8)	7 (2.2)	24 (17.1)	35 (9.1)	16 (12.1)	24 (6.5)
Pneumonia	20 (7.8)	73 (10)	11 (4.8)	18 (2.8)	20 (9.6)	46 (7.5)	9 (9.4)	19 (6.7)	60 (37.9)	156 (35.2)	40 (28.9)	83 (22.4)
Chronic obstructive pulmonary disease and allied conditions	30 (11.7)	29 (4)	5 (2.3)	17 (2.5)	22 (10.8)	48 (7.4)	8 (8.8)	31 (10.2)	65 (40.4)	125 (29.2)	35 (26.7)	96 (24.1)
Pulmonary effusion, pneumothorax, pulmonary collapse, acute respiratory failure	33 (12.8)	102 (14)	5 (2.3)	21 (3.4)	16 (8)	30 (5.2)	3 (3.4)	17 (6.2)	57 (36.3)	170 (37.7)	24 (19.4)	68 (19.5)
Gastrointestinal ulcers	9 (3.5)	13 (1.8)	9 (3.7)	10 (1.4)	23 (10.6)	63 (9.5)	13 (13.1)	29 (9.5)	54 (34.7)	115 (27.2)	45 (30.7)	102 (24.9)
Gastritis, duodenitis	6 (2.3)	2 (0.3)	2 (0.8)	12 (1.7)	14 (6.2)	39 (5.8)	4 (3.9)	16 (5.1)	26 (18.4)	69 (17.3)	20 (14.8)	67 (16.8)
Intestinal obstruction, constipation	16 (6.2)	40 (5.5)	9 (3.8)	30 (4.4)	25 (11.7)	61 (9.8)	6 (6.5)	19 (6.8)	56 (35.8)	150 (34.1)	40 (28.5)	110 (27.5)
Neurogenic bowel	25 (9.7)	79 (10.8)	5 (2.2)	14 (2.2)	2 (1)	15 (2.5)	0 (0)	0 (0)	32 (22.1)	108 (25.7)	7 (5.9)	29 (8.5)
Kidney infection	1 (0.4)	5 (0.7)	2 (0.8)	11 (1.5)	10 (4.4)	17 (2.6)	7 (6.6)	9 (2.9)	20 (14.4)	42 (10.9)	19 (13.8)	37 (9.7)
Neurogenic bladder	31 (12.1)	104 (14.2)	6 (2.7)	27 (4.4)	7 (3.6)	40 (7.2)	6 (6.6)	12 (4.7)	50 (32.6)	183 (40)	19 (15.5)	79 (22.4)
Urinary tract infection	81 (31.5)	145 (19.8)	22 (12.6)	64 (11)	26 (17.8)	66 (13.2)	10 (15.9)	22 (9.9)	139 (70.2)	297 (57.8)	58 (49.6)	152 (41.2)
Chronic skin ulcer	9 (3.5)	55 (7.5)	12 (4.9)	51 (7.6)	16 (7.4)	54 (9.1)	6 (6.1)	17 (6.3)	43 (28.7)	177 (39)	34 (24.1)	122 (30.6)
Rheumatoid arthritis, osteoarthritis	20 (7.8)	13 (1.8)	5 (2.2)	7 (1)	11 (5.2)	23 (3.5)	2 (2.1)	9 (2.9)	38 (25.8)	52 (13.3)	18 (14.1)	39 (10.3)
Joint, back pain	7 (2.7)	10 (1.4)	10 (4.1)	21 (3)	20 (9.3)	53 (8.2)	7 (7.4)	24 (8.1)	44 (29.2)	108 (25.7)	37 (25.8)	98 (23.9)
Disk disorders	61 (23.7)	149 (20.4)	9 (4.7)	30 (5.2)	20 (11.9)	58 (11.2)	15 (19.2)	30 (12.7)	105 (58)	267 (53.5)	44 (36.7)	118 (33.7)
Osteomyelitis	1 (0.4)	0 (0)	1 (0.4)	5 (0.7)	5 (2.2)	25 (3.7)	5 (4.7)	12 (3.8)	12 (8.9)	42 (10.9)	11 (8.2)	42 (10.9)

Table 5. Repeat Injuries and Repeat Acute Medical Conditions Observed During the Follow-up Period in Women (W) and Men

	1 Episode			2 Episodes			3+ Episodes					
	W	M	n (%)	W	M	n (%)	W	M	n (%)	Mean (SD)	Max	Mean (SD)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	Mean (SD)	Max	Mean (SD)
Septicemia and bacteremia	22 (73.33)	67 (72.04)	3 (10.0)	13 (13.98)	5 (16.67)	13 (13.98)	13 (13.98)	1.73 (1.51)	6	1.58 (1.25)	9	1.58 (1.25)
Nutritional deficiencies	9 (50)	39 (70.91)	7 (38.89)	9 (16.36)	2 (11.11)	7 (12.73)	2 (11.11)	2.11 (2.19)	10	1.62 (1.31)	7	1.62 (1.31)
Fluid, electrolyte, acid/base disorders	44 (51.76)	88 (52.07)	17 (20)	32 (18.93)	24 (28.24)	49 (28.99)	24 (28.24)	2.27 (2.23)	16	2.03 (1.47)	10	2.03 (1.47)
Pneumonia	31 (68.89)	50 (51.55)	7 (15.56)	29 (29.9)	7 (15.56)	18 (18.56)	7 (15.56)	1.93 (2.24)	11	1.97 (1.61)	10	1.97 (1.61)
Pulmonary effusion, pneumothorax, pulmonary collapse, acute respiratory failure	20 (80)	47 (62.67)	3 (12)	15 (20)	2 (8)	13 (17.33)	2 (8)	1.32 (0.75)	4	1.67 (1.09)	6	1.67 (1.09)
Gastrointestinal ulcers	29 (60.42)	71 (66.98)	6 (12.5)	16 (15.09)	14 (29.17)	16 (17.92)	14 (29.17)	2.44 (2.82)	16	1.75 (1.49)	9	1.75 (1.49)
Gastritis, duodenitis	17 (80.95)	46 (69.7)	3 (14.29)	15 (22.73)	1 (4.76)	5 (7.58)	1 (4.76)	1.24 (0.54)	3	1.42 (0.79)	5	1.42 (0.79)
Intestinal obstruction, constipation	28 (66.67)	70 (61.4)	6 (14.29)	22 (19.3)	8 (19)	22 (19.3)	8 (19)	1.93 (1.84)	8	2.18 (2.64)	13	2.18 (2.64)
Neurogenic bowel	4 (80)	19 (76)	0 (0)	4 (16)	1 (20)	2 (8)	1 (20)	1.6 (1.34)	4	1.32 (0.63)	3	1.32 (0.63)
Kidney infection	17 (85)	20 (55.56)	2 (10)	12 (33.33)	1 (5)	4 (11.11)	1 (5)	1.2 (0.52)	3	1.72 (1.21)	6	1.72 (1.21)
Neurogenic bladder	11 (61.11)	59 (60.2)	5 (27.78)	16 (16.33)	2 (11.11)	23 (23.47)	2 (11.11)	1.67 (1.14)	5	2.14 (2.06)	11	2.14 (2.06)
Urinary tract infection	39 (43.82)	66 (31.58)	20 (22.47)	42 (20.1)	30 (33.71)	101 (48.33)	30 (33.71)	3.46 (4.86)	31	4.34 (6.92)	78	4.34 (6.92)
Chronic skin ulcer	12 (34.29)	41 (28.47)	6 (17.14)	14 (9.72)	17 (48.57)	89 (61.81)	17 (48.57)	7.69 (12.23)	66	5.74 (6.48)	37	5.74 (6.48)
Osteomyelitis	9 (90)	23 (57.5)	0 (0)	7 (17.5)	1 (10)	10 (25)	1 (10)	1.3 (0.95)	4	1.98 (1.62)	8	1.98 (1.62)
Extremity fracture, dislocation, sprain, amputation	24 (60)	88 (70.97)	9 (22.5)	20 (16.1)	7 (17.5)	16 (12.9)	7 (17.5)	1.7 (1.11)	6	1.65 (1.58)	12	1.65 (1.58)
Traumatic brain injury, spinal cord injury, fracture of head, neck, face, spine	19 (100)	39 (90.7)	0 (0)	3 (7)	0 (0)	1 (2.3)	0 (0)	1 (0)	1	1.12 (0.39)	3	1.12 (0.39)
Poisoning	9 (64.3)	36 (85.7)	3 (21.4)	3 (7.1)	2 (14.3)	3 (7.1)	2 (14.3)	1.57 (0.94)	4	1.24 (0.66)	4	1.24 (0.66)
Other injury	42 (58.3)	138 (62.4)	13 (18.1)	43 (19.5)	17 (23.6)	40 (18.1)	17 (23.6)	1.97 (1.82)	11	1.97 (2.29)	19	1.97 (2.29)

9% (21,23,40). The finding that a higher proportion of patients in our study had died is puzzling, because our study includes patients with all severities and not just those with the most severe injuries who would be discharged from acute care rehabilitation facilities. Moreover, the comparison studies did not include an 89-day exclusion period after acute care hospital discharge to determine the cohorts. However, caution should be used when comparing findings from this study with other studies, because the methods of determining mortality status for this study may have been more complete and accurate than used elsewhere.

Most Prevalent Adverse Health Classes and Conditions

Adverse health classes with a prevalence rate greater than 60% in both men and women were noted (muscle/connective tissue, genitourinary, renal/urinary, digestive, circulatory, respiratory, and endocrine/nutritional/metabolic). All disease classes have been reported as possibly secondary to TSCI (1,3,5,8,9,41–43). When examining specific conditions, high incidences of urinary tract infection, ischemic heart disease, hypertension, disc disorders, chronic skin ulcers, bowel problems, nutritional and fluid disorders, respiratory complications, and pain were observed. These findings compare with adverse health conditions reported in other studies of people with TSCI (3,44–48) and comparable disabilities (49–52). For instance, the most commonly reported adverse health conditions that required rehospitalization of patients in the Spinal Cord Injury Model System were genitourinary complications, pressure ulcers, and respiratory complications (5).

Injury and Acute Medical Conditions

Incidence (Table 3), prevalence (Table 4), and repeat occurrence (Table 5) of medically attended acute medical conditions and injury after TSCI is disturbing, particularly considering that the majority of these conditions are preventable. Of note is that the incidence of injury in this study is greater in comparison with another study (53) that reported that nearly 20% of 1,328 people who had experienced TSCI for an average of 10 years had at least 1 injury per year that required medical attention, with approximately 5% requiring hospitalization. These findings suggest that further research is needed into circumstances that contribute to preventable medical conditions and injuries after TSCI so that prevention strategies can be implemented to prevent their occurrence. In particular, pneumonia, pulmonary emboli, and septicemia would be of great concern to control or modify, because they have been reported as causes of death that appear to have the greatest impact on reduced life expectancy in the Spinal Cord Injury Model System population (54).

Strengths and Limitations

The major strength of this study centers on the utilization of a prospective cohort design with a population-based statewide sampling of all people with new TSCI who during a 10-year period received medical attention in an ED, hospital, or hospital-associated outpatient clinic. The cohort design reduces selection bias, and the prospective follow-up and assessment of medical conditions by medical record eliminates recall bias. The population-based sampling increases the ability to generalize the study's findings to all people with new TSCI, not just those with the most severe injuries who receive medical rehabilitation. Additionally, the findings can inform public policy of the importance and usefulness of medical surveillance of TSCI to inform health care providers of conditions in which to modify and control long-term TSCI. Finally, the statistical method described in this manuscript can be applied to future investigations for deeper probing into a specific condition or set of conditions.

This study has a few limitations. First, the study does not include data on health care received out of state or in nonhospital-associated outpatient clinics. Second, incidence of TSCI could be inflated, because using ICD-9-CM methodology to identify TSCI without confirming with medical record review could overestimate incidence (33). Third, the current study is reliant on coding that is normally associated with billing, and any new or “trendy” syndromes or codes may not have been consistently applied throughout the follow-up period, especially if they do not affect billing. For example, metabolic syndrome for which code 277.7 was approved in 2001 is rarely, if ever, recorded as a diagnosis in clinical practice (55). Fourth, the aim of this paper is to provide prevalence and incidence estimates in the 10 years after injury for observed medical conditions in a population with TSCI. Thus, the relative occurrence of these conditions in other populations cannot be estimated. Therefore, further research is needed to determine whether these conditions are more prevalent or occur at an increased rate compared with other injured or able-bodied populations. Fifth, this research covers a 10-year period. A longer follow-up period would allow for conditions attributable to aging with TSCI to be noted.

CONCLUSIONS

Not surprisingly, this study revealed that people with TSCI encounter a variety of adverse health conditions that require medical attention in the 10 years after injury. Yet these conditions are not solely those generally considered secondary to TSCI. These findings have explicit implications for the long-term health management of people with TSCI. We recommend that a health care team with diverse specialties, not solely rehabilitation specialists, collaborate early after injury to develop a health management plan that provides for the continuum of care for each patient with TSCI. The ultimate goal

is to prevent, limit, or control modifiable adverse health conditions so that people with TSCI have the best possible health outcome, enhanced quality of life, and increased life expectancy.

REFERENCES

- Middleton JW, Lim K, Taylor L, Sodden R, Rutkowski S. Patterns of morbidity and rehospitalisation following spinal cord injury. *Spinal Cord*. 2004;42(6):359–367.
- Charlifue SW, Weitzenkamp D, Whiteneck GG. Longitudinal outcomes in spinal cord injury: aging, secondary conditions, and well-being. *Arch Phys Med Rehabil*. 1999;80(11):1429–1434.
- Noreau L, Proulx P, Gagnon L, Drolet M, Laramee MT. Secondary impairments after spinal cord injury: a population-based study. *Am J Phys Med Rehabil*. 2000;79(6):526–535.
- Munce SE, Guilcher SJ, Couris CM, et al. Physician utilization among adults with traumatic spinal cord injury in Ontario: a population-based study. *Spinal Cord*. 2009;47(6):470–476.
- Cardenas DD, Hoffman JM, Kirshblum S, McKinley W. Etiology and incidence of rehospitalization after traumatic spinal cord injury: a multicenter analysis. *Arch Phys Med Rehabil*. 2004;85(11):1757–1763.
- Davidoff G, Schultz S, Lieb T, et al. Rehospitalization after initial rehabilitation for acute spinal cord injury: incidence and risk factors. *Arch Phys Med Rehabil*. 1990;71(2):121–124.
- Waddimba AC, Jain NB, Stolzmann K, et al. Predictors of cardiopulmonary hospitalization in chronic spinal cord injury. *Arch Phys Med Rehabil*. 2009;90(2):193–200.
- Savic G, Short DJ, Weitzenkamp D, Charlifue S, Gardner BP. Hospital readmissions in people with chronic spinal cord injury. *Spinal Cord*. 2000;38(6):371–377.
- Klotz R, Joseph PA, Ravaud JF, Wiart L, Barat M, Tetrafigap Group. The Tetrafigap Survey on the long-term outcome of tetraplegic spinal cord injured persons: part III. Medical complications and associated factors. *Spinal Cord*. 2002;40(9):457–467.
- DeVivo MJ, Krause JS, Lammertse DP. Recent trends in mortality and causes of death among persons with spinal cord injury. *Arch Phys Med Rehabil*. 1999;80(11):1411–1419.
- Soden RJ, Walsh J, Middleton JW, Craven ML, Rutkowski SB, Yeo JD. Causes of death after spinal cord injury. *Spinal Cord*. 2000;38(10):604–610.
- Samsa GP, Landsman PB, Hamilton B. Inpatient hospital utilization among veterans with traumatic spinal cord injury. *Arch Phys Med Rehabil*. 1996;77(10):1037–1043.
- Eastwood EA, Hagglund KJ, Ragnarsson KT, Gordon WA, Marino RJ. Medical rehabilitation length of stay and outcomes for persons with traumatic spinal cord injury 1990–1997. *Arch Phys Med Rehabil*. 1999;80(11):1457–1463.
- Vaidyanathan S, Soni BM, Gopalan L, et al. A review of the readmissions of patients with tetraplegia to the Regional Spinal Injuries Centre, Southport, United Kingdom, between January 1994 and December 1995. *Spinal Cord*. 1998;36(12):838–846.
- Sekar P, Wallace D, Waites K, et al. Comparison of long-term renal function after spinal cord injury using different urinary management methods. *Arch Phys Med Rehabil*. 1997;78(9):992–997.
- Chang S, Hou D, Dong D, Shang H. Urological status of 74 spinal cord injury patients from the 1976 Tangshan earthquake, and managed for over 20 years using the Crede maneuver. *Spinal Cord*. 2000;38(4):552–554.
- McColl MA, Charlifue S, Glass C, Lawson N, Savic G. Aging, gender, and spinal cord injury. *Arch Phys Med Rehabil*. 2004;85(3):363–367.
- Chan L, Shumway-Cook A, Yorkston KM, Ciol MA, Dudgeon BJ, Hoffman JM. Design and validation of a methodology using the International Classification of Diseases, 9th Revision, to identify secondary conditions in people with disabilities. *Arch Phys Med Rehabil*. 2005;86(5):1065–1069.
- Ivie CS III, DeVivo MJ. Predicting unplanned hospitalizations in persons with spinal cord injury. *Arch Phys Med Rehabil*. 1994;75(25):1128–1188.
- Kroll T, Neri MT, Ho P. Secondary conditions in spinal cord injury: results from a prospective survey. *Disabil Rehabil*. 2007;29(15):1229–1237.
- O'Connor P. Survival after spinal cord injury in Australia. *Arch Phys Med Rehabil*. 2005;86(1):37–47.
- Lidal IB, Snekkvik H, Aamodt G, Hjeltne N, Stanghelle JK, Biering-Sørensen F. Mortality after spinal cord injury in Norway. *J Rehabil Med*. 2007;39(2):145–151.
- Dorsett P, Geraghty T. Health-related outcomes of people with spinal cord injury: a 10 year longitudinal study. *Spinal Cord*. 2008;46(5):386–391.
- International Classification of Diseases, Ninth Revision, Clinical Modification*. 6th ed. Washington, DC: United States Department of Health and Human Services; 1996.
- Chan L, Houck P, Praela CM, MacLehose RF. Using Medicare databases for outcomes research in rehabilitation medicine. *Am J Phys Med Rehabil*. 2001;80(6):474–480.
- Coleman E, Wagner EH, Grothaus LC, Hecht J, Savarino J, Buchner DM. Predicting hospitalization and functional decline in older health plan enrollees: are administrative data as accurate as self-report? *J Am Geriatr Soc*. 1998(4);46:419–425.
- Rawson NS, Malcolm E, D'Arcy C. Reliability of the recording of schizophrenia and depressive disorder in the Saskatchewan health care datafiles. *Soc Psychiatry Psychiatr Epidemiol*. 1997;32(4):191–199.
- Roos LL, Walld R, Wajda A, Bond R, Hartford K. Record linkage strategies, outpatient procedures, and administrative data. *Med Care*. 1996;34(6):570–582.
- Humphries KH, Rankin JM, Carere RG, Buller CE, Kiely FM, Spinelli JJ. Co-morbidity data in outcomes research: are clinical data derived from administrative databases a reliable alternative to chart review? *J Clin Epidemiol*. 2000;53(4):343–349.
- Thurman DJ, Snizek J, Johnson D, Greenspan A, Smith SM. *Guidelines for Surveillance of Central Nervous System*. Atlanta, GA: United States Department of Health and Human Services, National Centers for Disease Control and Prevention; 1995.
- Dahlberg A, Kotila M, Leppanen P, Kautiainen H, Alaranta H. Prevalence of spinal cord injury in Helsinki. *Spinal Cord*. 2005;43(1):47–50.

32. Thurman DJ, Burnett CL, Jeppson L, Beaudoin DE, Snizek JE. Surveillance of spinal cord injuries in Utah, USA. *Paraplegia*. 1994;32(10):665–669.
33. Hagen EM, Rekand T, Gilhus NE, Gromming M. Diagnostic coding accuracy for traumatic spinal cord injuries. *Spinal Cord*. 2009;47(5):367–371.
34. Surkin J, Gilbert BJ, Harkey HL III, Snizek J, Currier M. Spinal cord injury in Mississippi: findings and evaluation, 1992–1994. *Spine*. 2000;25(6):716–721.
35. The Johns Hopkins University and Tri-Analytics, Inc ICDMAP-90 Software User's Guide; 1997.
36. Prentice RL, Kalbfleisch JD. Hazard rate models with covariates. *Biometrics*. 1979;35(1):25–39.
37. *SAS/STAT 9.1 User's Guide*. Cary, NC: SAS Institute Inc; 2004.
38. Johnson RL, Gerhart KA, McCray J, Malesconi JC, Whiteneck GG. Secondary conditions following spinal cord injury in a population-based sample. *Spinal Cord*. 1998;36(1):45–50.
39. DeVivo MJ, Black KJ, Stover SL. Causes of death during the first 12 years after spinal cord injury. *Arch Phys Med Rehabil*. 1993;74(3):248–254.
40. Bloemen-Vrencken JHA, Post MWM, Hendriks JMS, De Reus ECE, De Witte LP. Health problems of persons with spinal cord injury living in The Netherlands. *Disabil Rehabil*. 2005;27(22):1381–1389.
41. LP Statacorp. Stata Statistical Software: Release 9.0. College Station, TX: Stata Corporation; 2005.
42. Chiodo AE, Scelza WM, Kirshblum SC, Wuermser LA, Ho CH, Priebe MM. Spinal cord injury medicine. 5. Long-term medical issues and health maintenance. *Arch Phys Med Rehabil*. 2007;88(3 suppl 1):S76–S83.
43. Dryden DM, Saunders LD, Rowe BH, et al. Utilization of health services following spinal cord injury: a 6-year follow-up study. *Spinal Cord*. 2004;42(9):513–525.
44. Pagliacci MC, Celani MG, Spizzichino L, Zampolini M, Franceschini M, Gruppo Italiano Studio Epidemiologico Mielolesioni. Hospital care of postacute spinal cord lesion patients in Italy: analysis of readmissions into the GISEM study. *Am J Phys Med Rehabil*. 2008;87(8):619–626.
45. Levi R, Hultling C, Seiger A. The Stockholm Spinal Cord Injury Study: 2. Associations between clinical patient characteristics and post-acute medical problems. *Paraplegia*. 1995;33(10):585–594.
46. Meyers AR, Felton M, Master RJ, et al. Rehospitalization and spinal cord injury: cross-sectional survey of adults living independently. *Arch Phys Med Rehabil*. 1985;66(10):704–708.
47. Walter JS, Sacks J, Othman R, et al. A database of self-reported secondary medical problems among VA spinal cord injury patients: its role in clinical care and management. *J Rehabil Res Dev*. 2002;39(1):53–61.
48. Widerstrom-Noga EG, Felipe-Cuervo E, Broton JG, Duncan RC, Yezierski RP. Perceived difficulty in dealing with consequences of spinal cord injury. *Arch Phys Med Rehabil*. 1999;80(5):580–586.
49. Chan L, Doctor JN, MacLehose RF, et al. Do Medicare patients with disabilities receive preventive services? A population-based study. *Arch Phys Med Rehabil*. 1999;80(6):642–646.
50. Kinsman SL, Doebling MC. The cost of preventable conditions in adults with spina bifida. *Eur J Pediatr Surg*. 1996;6(suppl 1):17–20.
51. Gajdosik CG, Cicirello N. Secondary conditions of the musculoskeletal system in adolescents and adults with cerebral palsy. *Phys Occup Ther Pediatr*. 2001;21(4):49–68.
52. Campbell ML, Sheets D, Strong PS. Secondary health conditions among middle-aged persons with chronic physical disabilities: implications for unmet needs for services. *Assist Technol*. 1999;11(2):105–122.
53. Krause JS. Factors associated with risk for subsequent injuries after traumatic spinal cord injury. *Arch Phys Med Rehabil*. 2004;85(9):1503–1508.
54. Spinal Cord Injury Facts and Figures at a Glance. April 2009. Available at: www.uab.edu/NSCISC National Spinal Cord Injury Statistical Center, University of Alabama-Birmingham. Accessed January 20, 2010.
55. Ford ES. Rarer than a blue moon: the use of a diagnostic code for the metabolic syndrome in the U.S. *Diabetes Care*. 2005;28(7):1808–1809.